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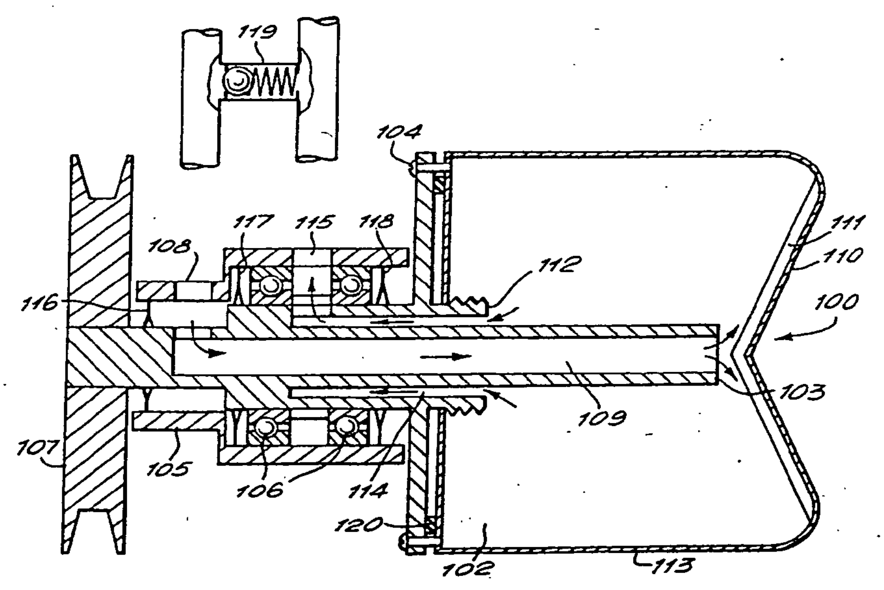

(57) Abstract

An engine lubricating oil system comprises a centrifugal separator (4) placed in a lubricating oil flow circuit so that oil passes therethrough to be cleaned. The separator has a hollow rotor body (102) and engages powered drive means (107), so that the drive is independent of the flow through the rotor. The separator may be placed between the sump and the engines working parts to act as a full flow filter or may continuously filter the sump oil.

CENTRIFUGAL SEPARATOR

This invention relates generally to centrifugal separators for removing contaminants from fluids and to fluid cleaning systems employing such systems. It is particularly, but not exclusively, concerned with the cleaning of lubricating oil and fuel in engines, transmissions and other devices.

In internal combustion engines, lubricating oil is cleaned in variety of ways. In a "full flow" filtration system, all the oil delivered by the engine's oil pump is passed through a fibrous filter element to the working components of the engine. The filter is essentially a mechanical strainer and, depending on the density and pore size of the filter medium, can be very effective in removing particulate material from the oil. It does however suffer from severe constraints. In order to achieve a flow rate and an acceptable pressure drop across the filter which will allow a satisfactory supply of oil to the engine, the pore size of the filter is usually within the range 10 to 40 microns. Although small, this will still allow the passage of particles which are potentially damaging to moving parts where oil clearances may be as small as 1 micron or less. In addition, as the filter becomes clogged, it does not have the ability to allow sufficient oil for the needs of the engine to pass through it. A by-pass valve is thus usually employed which will allow the filter to be by-passed to varying degrees and so allow unfiltered oil into the engine which is obviously undesirable. Furthermore, filters tend to remove additives from, and thus degrade, the oil.

In another system, so called "by-pass" filtration, a proportion (normally 10%, and 20% at most) of the oil delivered by the oil pump is by-passed through a secondary filter and is returned directly to the engine

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sump without lubricating the engine's working components. The remainder of the oil pump output is delivered to the working components either directly or through a primary filter as described above. By-pass filters may be an improvement on full flow filters since because they do not inhibit the pressure or flow of oil through the engine, they can be made more effective in filtering out smaller particles. It still remains however that as it passes into the engine, the oil is either unfiltered or only relatively coarsely filtered.

In some engines, a combined full flow/by pass filtration is used and while obviously superior to either system separately, it retains the inherent shortcomings of both, and furthermore is expensive.

Although fibrous elements are sometimes used, it is common to use a centrifugal separator as a by-pass filter. Such separators comprise a casing inside which is rotatably mounted a generally vertical, hollow rotor. The by-pass oil is fed under the pressure of the oil pump to the inside of the rotor and exits to the casing as jets through oppositely arranged tangential openings in the rotor, driving the rotor by reaction. During rotation, therefore contaminants in the oil are centrifuged to the side wall of the rotor where they accumulate to be cleaned out at some later stage or, if the rotor is disposable, to be thrown away with the rotor. The cleaned oil issuing as jets from the tangential openings collects in the casing from where it is returned usually by gravity to the engine sump. Typical constructions are shown in patent numbers GB 1595816, GB 2049494B and GB 2193123A for example.

The use of a reaction jet centrifugal separator as a by-pass filter is an improvement over using conventional filters. It still however suffers from not only the inherent problems of a by-pass system such as not being able to prevent contaminated oil passing into the engine through the primary filter (if present) but

also others. In particular, the device does not perform well under conditions of low oil pressure and low oil temperature. Although its performance improves with increasing oil temperature, during start up of the engine and operation before the engine reaches its normal operating temperature, oil passing through the device may not be effectively cleaned. In any event, the R.P.M of the device and thus the size of particle which may effectively be removed from the oil is constrained by the relatively small volume of oil (usually 10% of engine total) available to it. This is exacerbated in engines which have a marginal surplus of oil in circulation or in worn engines where the by-pass oil flow is reduced. Furthermore, the device must be mounted within 20% of vertical or else the cleaned oil ejected from the tangential openings of the rotor will build up in the device casing to the extent that it may impinge on the rotor and slow it down to the point where it becomes virtually ineffective.

There is thus a need for an improved separator and system for cleaning, for example, engine lubricating oil.

The present invention thus proposes from one aspect, an engine lubricating oil system comprising a centrifugal separator which is placed in a lubrication oil flow circuit such that oil passes through and is centrifuged by said separator, said separator having a rotor body and means engaging a powered drive means to rotate the rotor, which powered rotor drive means is independent of the oil flow through the separator.

By employing a centrifugal separator, the draw backs of porous filters are overcome. Furthermore the potential disadvantages of a reaction jet type separator are avoided by separating the rotor drive from the oil flow. Thus the present invention will allow effective cleaning of the engine oil, when the oil is cold or when the engine is starting.

An advantage of this aspect of the invention is that the separator may be used as a full flow oil filter, since the effectiveness of the separator will not be limited by the flow passing therethrough. With such an arrangement, there is continuous centrifuging of all the engine oil. Other forms of oil cleaning or filtering may therefore be dispensed with.

Preferably the rotor is driven directly from the engine, for example by a belt and pulley or gear arrangement, although it could equally well be driven by electrical, pneumatic, hydraulic or exhaust turbine means. By such an arrangement, even when the oil is cold, there will be effective filtering since the rotor will rotate in accordance with the speed of the engine.

The rotor body may be cleanable or disposable. In either event, it is believed that the separator could extend oil change periods in internal combustion engines up to and perhaps even beyond every 100,000 km. This would result in a considerable saving for operators who presently change oil and replace filters every 10,000 km. With a cleanable rotor, the need to purchase replacement filters would substantially be done away with.

In one embodiment, the centrifugal separator is placed directly in the oil flow path between the engine sump and the engine's working parts. Thus all the oil will pass through and be cleaned by the separator directly as it passes into the engine or returns therefrom.

In a second embodiment, the separator continuously receives oil from the engine sump, cleans it and returns it to the sump from where it is supplied to the engine. Thus in this case, the oil is kept clean in the sump and can be distributed to the engine from there. This embodiment makes particular use of the cumulative efficiency of the centrifugal separator.

The present invention is applicable not only to

engine oil cleaning as referred to above, but also to other applications where oil must be filtered such as power transmission trains, gearboxes, differentials and hydraulics; another aspect is applicable to the cleaning of other engine fluids such as fuel.

In regard to fuel, it is becoming increasingly important, particularly for compression ignition engines and fuel injection in petrol engines that the fuel is absolutely clean. Again the conventional method of cleaning is by various filtering devices which, as stated above may have drawbacks.

Accordingly from a further aspect, the invention provides a fuel supply system for an engine comprising a centrifugal separator for location in the fuel supply line to the engine, said separator comprising a driven rotor having means engaging powered drive means for rotating the rotor.

In a preferred embodiment, an intermediate vessel is provided in the fuel supply system, and the contents of this intermediate vessel continually centrifuged. Preferably the vessel is divided into two chambers, fuel being supplied to a first chamber, passed through said separator and returned to a second chamber from where it is supplied to the engine. Advantageously the first and second chambers are connected so as to allow cleaned fuel to pass from the second chamber back into the first chamber, so that it is again passed through the separator for further cleaning. Advantageously the chamber is divided by a baffle, over which the fuel in the second chamber may flow into the first chamber. A connection may also be provided between the first and second chambers whereby fuel may flow directly from said first chamber into said second chamber should the centrifugal separator cease to function. Ideally the capacity of the intermediate vessel should allow its contents to be circulated through the centrifugal separator at a rate no less than 20 times the rate at

which fuel is drawn off by the engine.

The preferred separator of the invention for whatever application essentially comprises a hollow rotor rotatably mounted on a support said rotor having means for engaging with an external, powered drive and having inlet and outlet means whereby fluid may enter at one end of the rotor and exit at the other.

The rotor may be a light steel or other metal pressing or may even be manufactured from a plastics material, and the support may either be an integral part of an engine or be adapted to be fitted to an engine or another support.

The rotor is preferably generally cylindrical in shape and has a fluid inlet to the rotor chamber adjacent one end of the rotor and close to the axis of rotation. This end of the rotor is preferably convex or concave in shape and may be fluted or grooved in order to give the oil (or other fluid) to be cleaned an additional rotational impetus.

The outlet from the rotor chamber is at the opposite end of the rotor from the inlet. This arrangement establishes a circulation of fluid and contaminants through the rotor. As they pass along the length of the rotor, heavy bodies, dirt, acid, water, impurities and abradings from the engine will be centrifuged and deposited on the rotor's outer wall. If a cleanable rotor is used, the deposits may be removed from the wall when desired and the rotor replaced. Alternatively, if a disposable rotor is used, this may be replaced whenever deemed necessary.

The cleaned oil for example then leaves the chamber through the outlet and is fed to the engine for lubrication purposes. As a further feature, a screen may be provided around the outlet to prevent accidental ingress of deposits into the outlet when, for example, the rotor has stopped.

A pressure relief valve may be provided on the

outlet side of the device to relieve excess pressure in the device and to return centrifuged oil to the engine sump.

It is also possible to provide a by-pass between the inlet and outlet to prevent a blockage of the system should the rotor become blocked.

Several inlet and outlet arrangements may be envisaged. In one preferred arrangement, the rotor body is attached to a hollow drive shaft which is rotatably mounted via bearings in a support body. The shaft extends along the axis of the rotor and discharges the fluid adjacent one end of the rotor along its axis. The drive shaft may be driven by any convenient means e.g. belt and pulley, gearing etc.. The fluid outlet may then be formed as an annulus in the other end of the rotor, around the drive shaft.

In another embodiment, the rotor body may be rotatably mounted on a static body which extends along the axis of the rotor which is again driven directly by any convenient means. Passages formed in the body discharge inlet oil at one end of the rotor and lead it away from the other end of the rotor.

The rotor may be mounted vertically, horizontally or in any convenient attitude, either on or, if necessary, remote from the engine. It does not suffer from the disadvantage of the reaction jet centrifuge which must be mounted vertically to operate successfully. The device is therefore more adaptable to various installations.

As stated above, the invention is applicable not only to the filtering of lubricating oil but also to engine fuel, and to this end, a single device may provide for the simultaneous filtering of oil and fuel.

In one arrangement respective filtering chambers may be provided in separate rotor bodies at opposite ends of a single drive shaft. In another, a single rotor body may be provided which is subdivided

lengthwise into two or more chambers.

A separator in accordance with the invention may also comprise impeller means which result in the device having a positive pumping effect as well as a separating effect. The impeller may be constructed as vanes provided on an end surface of the rotor body adjacent the fluid inlet. Guide means may be provided which help to direct the liquid to the outer wall of the rotor body where impurities will be deposited by centrifugal action.

In order to further control the flow of fluid through the rotor, means may be provided within the rotor between the inlet and outlet for defining a generally helical flow path for the fluid.

Thus a helix, spiral, screw scroll worm or the like may be provided in the rotor, to cause the liquid to follow a regular and spiral course through the centrifuge. The device will revolve with the rotor.

This will prevent fluids taking an almost straight line path between the inlet and outlet, which is undesirable since in doing so they will create dead and turbulent areas. Liquids occupying these dead and turbulent areas of the rotor have slowed down and are in fact filling space within the rotor. This of course will cause the rest of the liquid passing through to be speeded up. Thus the liquid in the dead and turbulent areas may be resident for longer than is necessary, whilst the rest of the liquid may not remain within the rotor for long enough. It therefore will not be properly cleansed. Introduction of a helical flow path will even out the flow, remove the dead and turbulent areas and so greatly improve the effective residence time of the liquid within the rotor.

The helical flow means need not extend over the whole length of the rotor.

In a further embodiment radially extending vanes may be provided generally in the rotor body which cause

entering fluids to assume the same rotational speed as the rotor itself and so prevent slippage thereof.

The features of helical flow path and radial vanes may be provided together in the same rotor. For example, a helical element may be mounted adjacent the inlet to the rotor to accelerate the rotational speed of the entering fluid so that contaminants are quickly flung to the periphery of the rotor. However the speed may be such that the contaminants are not easily deposited on the rotor outer wall by virtue of the 'washing' effect of the fluid. Radial vanes may then be provided adjacent the outlet, to slow the rotational speed of the fluid down to that of the rotor itself to allow contaminants to be deposited on the wall.

Several embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 shows, schematically, a first oil lubricating system embodying the invention;

Figure 2 shows, schematically, a second oil lubricating system embodying the invention;

Figure 3 shows, schematically, a fuel supply system embodying the invention;

Figure 4 shows an oil centrifuge embodying the invention;

Figure 5 shows a first embodiment of a combined oil and fuel centrifuge in accordance with the invention; and

Figure 6 shows a second embodiment of a combined oil and fuel centrifuge in accordance with the invention.

Figure 7 shows a combined pump and centrifuge embodying the invention.

Figure 8 shows a new Figure 7 looking in the direction of arrow "A".

Figure 9 shows a yet further embodiment of a separator; and

Figure 10 shows a schematic view of a separator rotor body.

Referring firstly to Figure 1, an engine block 1 has a sump 2, from which leads a passage 3 to the inlet of a centrifugal separator 4. A passage 5 leads from the outlet of the separator 4 to the engine's oil pump 6. A passage, not shown, leads from the pump 6 to the engine's working parts. The separator 4 is driven by a belt 7 driven by a crankshaft pulley 8 with a belt tensioner 9. Lubricating oil is therefore drawn through the separator 4 by the oil pump 6, so that all of the oil in circulation will pass through the separator 4 before reaching the working parts of the engine.

In a modification (Figure 2) of the system shown in Figure 1, the separator 4 continually cleans the oil in the sump 2. In this embodiment, therefore, rather than leading to the oil pump 6, the return passage 5 from the separator 4 exhausts back into the sump 2. A pump (not shown) may supply the oil to the separator 4 but preferably the separator 4 includes in built pumping vanes, as will be described later. Since, in this embodiment, the separator 4 is independent of the oil pump 6, it may accommodate a higher flow rate than the first embodiment, and it also makes use of the accumulative separating efficiency of the separator. Suitable means may be provided in the sump 2 to ensure that oil returned to the sump 2 from the engine 1 will not flow directly to the pump 6, but will first pass through the separator 4.

Turning now to Figure 3, an engine's fuel system comprises a fuel tank 10, an intermediate vessel 11, which is connected to the tank 10 by a conduit 12. The intermediate vessel 11 is divided into two chambers, 11a, 11b by a baffle 13. The baffle 13 does not extend to the top of the vessel 11 and allows free flow of fuel from one chamber to the other. A conduit 14 leads from the chamber 11a to the inlet of a centrifugal separator

15 driven by a power take off 18 of the engine and a return conduit 16 leads from the outlet of the separator 15 to the chamber 11b. Cleaned fuel is then drawn off by the engine through conduit 17 leading from the base of vessel 11, at the desired rate. Pump means may be provided in the supply conduit 14, or the separator may incorporate pumping vanes or the like.

In use, the vessel 11 will be maintained substantially full, with fuel entering the vessel 11 from the tank 12 at the same rate as the engine draws fuel from the vessel 11. However the fuel will be circulated within the vessel 11 at a higher rate, preferably at least twenty times the rate at which fuel is drawn off by the engine. This is possible since the fuel cleansed by the separator 15 when returned to chamber 11b can flow over the top of the baffle 13 to pass through the separator 15 again to be further cleansed. As such fuel supplied to the engine will have been subjected to a cumulative cleaning effect by the separator 15.

The baffle 13 may also be provided with an orifice (not shown) near its lower end to connect the chambers 11a and 11b in the event that the separator 15 cease to function, so that sufficient fuel may be supplied to the engine.

So that the vessel 11 may be primed initially, a vent valve 19 may be provided in the upper part of the vessel 11 to allow fuel to enter and fill the vessel 11. Also, in engines which return a proportion of the fuel to the fuel tank, this return flow may be supplied to the chamber 11a by conduit 20. It should be noted that vessel 11, while shown as being separate from the main tank 12, could form part of the tank 12.

Figures 4 to 10 describe constructions of separators which are suitable for use in the above systems.

Referring to Figure 4, there is shown an engine

lubricating oil cleaner 100 comprising a disposable rotor body 102 which is mounted for rotation with a drive shaft 103 via lock screws 104. The drive shaft 105 is rotatably mounted in support body 105 by bearings 106 and is rotated directly by the engine via a drive pulley 107. Support body 105 may be integral with the engine or mounted either directly on the engine or remotely from it.

Oil from the engine's oil pump enters the rotor via a port 108 in the support body 105, and a passage 109 running along the axis of the drive shaft 103. Upon leaving the passage 109, the oil impinges on the end surface 110 of the rotor body 102 which is convex in shape and which has fluting 111 to give the oil a rotational impetus. The oil circulates through the rotor body 102 to an annular outlet 112 formed in the drive shaft 103. As the oil circulates through the rotor body 102, dirt and other impurities will be centrifuged outwardly and deposited on the outer wall 113 of the rotor body 102.

From the outlet 112, the oil passes through a passage 114 in the drive shaft to an exit port 115 in the support body 105 from where it is conducted to the engine. Thus all the oil which leaves the oil pump passes through the separator before reaching the engine. Seals 116,117,118 prevent leakage of the inlet and outlet oil from between the support body 105 and drive shaft 103. Furthermore by such an arrangement, the clean oil lubricates the bearings 106 as it leaves the device. Also, a seal ring 120 prevents leakage of oil from between the rotor body 102 and the drive shaft 103.

A safety by-pass valve 119 may be provided between the oil inlet and outlet lines so that should the rotor block for some reason, or oil pressure within the system become excessive, relief will be provided, and oil, albeit uncleaned oil, will still be able to reach the engine parts.

Figure 5 shows a combined fuel and oil filter embodying the invention. An oil cleaning rotor body 21 and a fuel cleaning rotor body 22 are mounted on drive shaft 23. As in the embodiment of Figure 1, the oil cleaning rotor body 22 is attached to the drive shaft 23 via locking screws 24 although any convenient attachment means could be used. Fuel cleaning rotor 22 is attached to drive shaft 23 by suitable means. Both rotors may be either cleanable or disposable.

As in the embodiment of figure 4, the drive shaft 23 is supported in a body 124 which may be mounted in any desired attitude on or remotely from the engine, or indeed be integral with it, via bearings 25. Although shown as ball bearings, any form of bearing such as a roller or needle bearing or a bush or any combination of these may be used. A bearing locking ring 37 is provided adjacent one of the bearings 25. The drive shaft 23 may be supported at any attitude, and is driven by any suitable means e.g. belt and pulley, electrical etc. Oil from the engine's oil pump enters through port 26 in the support body 124 and passes along a passage running along the axis of the drive shaft 23. The oil exits the passage adjacent one end 27 of the rotor body which is concave in shape and which is formed with flutes 28 on its inner surface. The oil circulates through the rotor body to the annular outlet 68 formed in the drive shaft 23 from where it is conducted through port 29 in the support body 124 to the engine. A screen 30 is provided around the outlet 68 to prevent ingress of particulate matter to the outlet 68.

As the rotor body rotates, the oil passing therethrough is subject to considerable centrifugal force (the flutes 27 giving an additional rotational impetus to the oil), and contaminants heavier than the oil will be deposited onto the wall of the rotor body where they will adhere and form a dense deposit, which can be cleaned from the rotor from time to time or

thrown away with the rotor.

The fuel cleaning rotor body 22 is mounted on the opposite end of the drive shaft 23 from the oil cleaning rotor body 21. Fuel from the fuel pump is supplied via port 31 in the support body 124 along a passage 32 running along the axis of the drive shaft 23. The fuel leaving passage 32 impinges on the concave end wall 33 of the rotor body 22 and circulates around the rotor body 22 to an annular outlet 34 formed in the drive shaft 23 from where it is conducted via outlet port 35 in the support body 124, to the engine. Again the end wall of the rotor body 22 has flutes 36 to give the fuel a rotational impetus. As in the oil cleaning rotor body, the fuel will be subjected to considerable centrifugal force and impurities heavier than the fuel will be deposited on the outer wall 36 of the rotor body 22.

A single lip seal 38 and double lip seal 39 prevent leakage of cleaned oil from between the drive shaft 23 and support body 124 and also form a bearing lubrication chamber. Seal 39 also isolates the unclean oil entering the rotor from the cleaned oil leaving. A ring seal 40 is also provided between the rotor body 21 and the drive shaft 23.

A single lip seal 41 prevents leakage of cleaned fuel from between the drive shaft 23 and support body 124. A double lip seal 42 serves to isolate the incoming and outgoing fuel. Single lip seals 43 act to separate the fuel and oil from one another, but in the event that either fluid does pass its respective seal, a drain port 44 is provided in the support body for its removal.

With reference now to Figure 6, a second combined oil and fuel cleaner is disclosed. In this construction, however, rather than there being two distinct rotor bodies, there is a single rotor body 45 which is divided by a wall 46 into an oil cleaning

chamber 47a and a fuel cleaning chamber 47b.

The rotor 45 is mounted on support body 48 which can be mounted in any desired attitude to an engine or remote from it by any suitable means such as a bracket 55 a flange, or a saddle and clip arrangement. Alternatively, if the device is being fitted to the engine as part of its original equipment, it may form an integral part of the engine.

The rotor body is supported at one end by a bearing 49. Although a single ball bearing is shown, this bearing may comprise one or more ball, roller or needle bearings or bushes or indeed any combination of these. The rotor is supported at its other end by a peripherally grooved bush 60 through a bush carrier 62.

The rotor body 45 is rotated by pulley 50 which is clamped to the end face 51 of the rotor body by locking screws 52 and a plate 53 which also mounts an oil seal 54. The pulley 50 may be driven directly from the engine, but of course could be driven by other suitable means.

The support body 48 is formed with a plurality of passages 56-59 which conduct fuel and oil to and from the oil and fuel chambers 47a, 47b. Contaminated oil flows along passage 58 into a passage 61 formed between the bush carrier 62 and the support body 48, through the peripheral grooves of bush 60 and on to the fluted concave end surface 63 of oil chamber 47a. The flutes help to fling the oil outwards and it circulates around the oil chamber to an outlet 64 at the opposite end of the chamber and from there through passage 59 to the engine. Contaminant bodies suspended in the oil and heavier than the oil will be deposited on the outer wall of the oil chamber by centrifugal force and will form into a dense cake there.

A sealing ring 65 is provided around a shoulder on the bush carrier 62 so as to keep the contaminated and cleaned oil separate from one another. Seals 54 and 67

prevent egress of cleaned oil from behind the bearing 49 and from between the rotor and the pulley 50 respectively. Cross contamination between the oil and fuel is prevented by a double lipped seal 66. Generally however, the oil pressure will be higher than the fuel pressure so that if leakage did occur, this would be by way of oil gaining ingress to the fuel. Whilst this will cause the engine to smoke or indeed stop it, if the leakage is severe, the engine would not however be damaged.

Contaminated fuel is admitted to the fuel chamber 48 via a passage 57 and after circulating through the chamber, leaves via passage 56. Again, contaminants in the fuel will, under the action of centrifugal force, be deposited on the outer wall of the chamber.

The device of Figure 6 can also be used to filter only one fluid and if necessary could be split at X to provide a single chamber rotor.

As in the embodiments of Figures 4 and 5, a pressure relief valve may be provided to vent excess oil pressure back to the engine sump, and a by-pass may also be provided to cater for the unlikely eventuality that the rotor may block. It should be noted that a common feature of all the above described embodiments is that should the rotor drive be disabled for some reason, oil and/or fuel, albeit uncleaned would still be pumped through the device to the engine. A visual or audible warning could be provided to alert the operator that the rotor has ceased to rotate.

With reference to Figures 7 and 8, a combined pump and centrifuge is shown. A hollow rotor body 70 is mounted for rotation on body 71 by bearings 72. The rotor body 70 is rotated through a pulley 73 keyed to the end of shaft 74 on which is threadedly mounted the rotor body 70. The rotor body 71 is formed on one end with curved impeller vanes 75 and a guide plate 76. A running seal 77 is provided between the end of the shaft

74 and the inner edge of the vanes 75.

In use liquid to be pumped/cleansed enters through a port 78 formed in the body 71 into an annular inlet gallery 84 from where it enters the shaft 74 through an opening 79. After passing along the bore of the shaft 74, the liquid impinges upon the vanes 75, and, being contained by the guide plate 76 is flung to the outer wall of the rotor body 70. Seal 77 ensures that substantially all liquid exiting the bore of shaft 74 passes through the vanes 75. A baffle 80 causes the liquid to flow down the periphery of the rotor to outlet ports 81 from where it enters outlet gallery 82 and then outlet port 83.

Impurities and contaminants are deposited on the outer wall of the rotor body 70 by virtue of centrifugal force, to form a cake which may be cleaned out at appropriate intervals upon removal of the rotor body 70.

Preferably the device is installed below the level of the liquid which it will pump/cleanse so that it will be self priming.

Referring now to Figure 9, a further separator construction is shown. Hollow rotor body 200 is mounted for rotation on a support 201 via bearings 202,203. The support 201 extends along the axis of the body 200 to introduce fluid to be cleaned to one end of the rotor. The bearing 203 is arranged at that end of the support 201 and is located on the rotor inside a carrier 204. The inlet end of the rotor 200 is convex and provided with flutes 205 as described in earlier embodiments.

The other end of the rotor body 200 is threadedly engaged with a carrier plate 205, with an oil seal 206 arranged therebetween. The bearing 202 is arranged between the carrier plate 205 and the support 201 and located by a clamping plate 207. Suitable oil seals are provided to prevent oil escaping around or through the bearing 202.

The carrier plate 205 also provides a pulley 208

around which a belt drive may be trained.

The support 201 is provided with an annular outlet 209 whereby fluid may enter the outlet pipe 210, which is retained on the support by a nut 211. The outlet 209 extends around the axis of the support body 201, being divided into segments by, for example, four relatively slender pillars 212 which support the bearing 202.

Figure 10 shows, schematically a further rotor design which could be used in separators as described above. In this embodiment, a helical element 220 is arranged at the inlet end of a rotor body 221, and four, equispaced, radially extending vanes 222 are provided at the outlet end of the rotor body 221. Baffles may be provided at the inlet and outlet ends to channel the fluid to the radially outer parts of the rotor. Either of these formations may be used separately in rotor bodies, and they may extend either along substantially the whole length or only part of the length of the rotor body.

Separators in accordance with the invention may be driven by any convenient external means for example by electric motor or belt driven, with suitable gearing for the particular application. The device is suitable for use in a wide variety of applications such as cleaning/pumping water in swimming and other pools, tubs, cleaning/pumping fuels, or provide potable water from rivers, lakes or other sources, preferably in the case of the latter, with the provision of a suitable anti bacterial device.

It will thus be apparent from the above that at least in preferred embodiments, the invention provides for the full flow filtering of engine lubricating oil. All the oil is cleaned all of the time so that under normal circumstances only cleaned oil is fed to the engine. As such, conventional methods of filtration will no longer be necessary and if a cleanable rotor is used, it will not be necessary to replace oil filter

cartridges of other filter elements. Periods between oil changes can also be extended and in fact engine life may be greatly prolonged as abrasive contaminants will be efficiently removed from the oil. In addition, by centrifuging the oil, active additives are not removed from the oil. Furthermore, the centrifuge rotor is not driven by reaction jets as is the case in present by-pass centrifuges. This leads to improved performance when the oil is cold for example and means that the centrifuge can be mounted in any convenient attitude, not necessarily vertical as is the case in reaction jet devices. The device is fail safe since if the rotor drive fails, oil will still be pumped through the rotor to the engine. Furthermore, the device may be fitted to an engine as original equipment or easily retrofitted to an engine. Of course the invention is not limited to the cleaning of engine lubricating oil, and there are also disclosed herein arrangements for the cleaning of fuel. The device of the invention is also equally applicable to the cleaning of oil or fuel in other equipment such as transmission trains, differentials, etc.

The invention also extends to cleaning and pumping of many other liquids.

CLAIMS

1. An engine lubricating oil system comprising a centrifugal separator which is placed in a lubrication oil flow circuit such that oil passes through and is centrifuged by said separator, said separator having a rotor body and means engaging a powered drive means to rotate the rotor, which powered rotor drive means is independent of the oil flow through the separator.

2. A system as claimed in claim 1 wherein said centrifugal separator is placed directly in the oil flow path between the engine sump and the engine's working parts.

3. A system as claimed in claim 1 wherein said separator continuously receives oil from the engine sump, cleans it and returns it to the sump from where it is supplied to the engine.

4. A fuel supply system for an engine comprising a centrifugal separator for location in the fuel supply line to the engine, said separator comprising a driven rotor having means engaging powered drive means for rotating the rotor.

5. A system as claimed in claim 4 wherein an intermediate vessel is provided in the fuel supply system, and the contents of this intermediate vessel continually centrifuged.

6. A system as claimed in claim 5 wherein said vessel is divided into two chambers, fuel being supplied to a first chamber, passed through said separator and returned to a second chamber from where it is supplied to the engine.

7. A system as claimed in claim 6 wherein said first and second chambers are connected so as to allow cleaned fuel to pass from the second chamber back into the first chamber, so that it is again passed through the separator for further cleaning.

8. A system as claimed in claim 7 wherein said chamber is divided by a baffle, over which the fuel in the second chamber may flow into the first chamber.

9. A centrifugal separator for use in a system as claimed in any of claims 1 to 8, comprising a hollow rotor rotatably mounted on a support, said rotor having means for engaging with a powered drive means and having inlet and outlet means whereby fluid may enter at one end of the rotor and exit at the other.

10. A separator as claimed in claim 9 wherein said rotor is generally cylindrical.

11. A separator as claimed in claim 9 or 10 wherein said rotor has a fluid inlet to the rotor chamber adjacent one end of the rotor and close to the axis of rotation.

12. A separator as claimed in claim 11 wherein said end is convex or concave in shape.

13. A separator as claimed in claim 11 or 12 wherein said end is fluted or grooved in order to give the oil or other fluid to be cleaned an additional rotational impetus.

14. A separator as claimed in any of claims 9 to 13 wherein rotor body is rotatably mounted on a static body which extends along the axis of the rotor.

15. A separator as claimed in any of claims 9 to 14 further comprising impeller means to impart a pumping effect to the fluid being cleaned.

16. A separator as claimed in claim 15 wherein said impeller means comprises vanes provided on an end surface of the rotor body adjacent the fluid inlet.

17. A separator as claimed in any of claims 9 to 16 comprising means provided within the rotor between the inlet and outlet for defining a generally helical flow path for the fluid.

18. A separator as claimed in any of claims 9 to 17 comprising radially extending vanes provided generally in the rotor body which cause entering fluids to assume the same rotational speed as the rotor.

19. A separator as claimed in any of claims 9 to 18 wherein said means for engaging said powered drive means is a pulley wheel drivingly connected with said rotor body.

FIG.1.

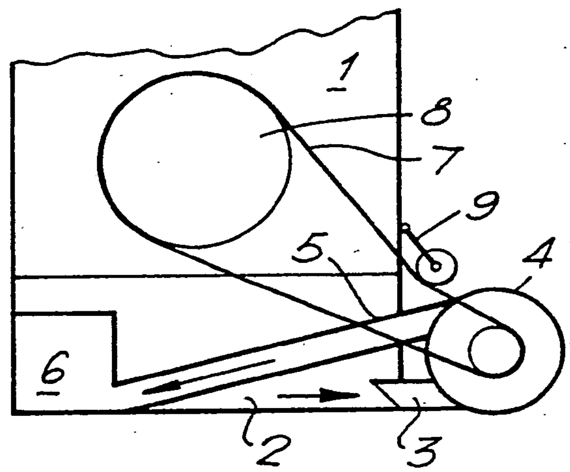


FIG.2.

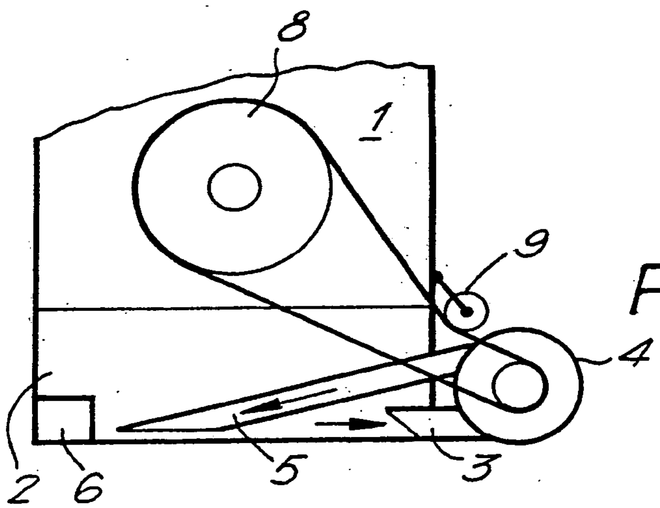
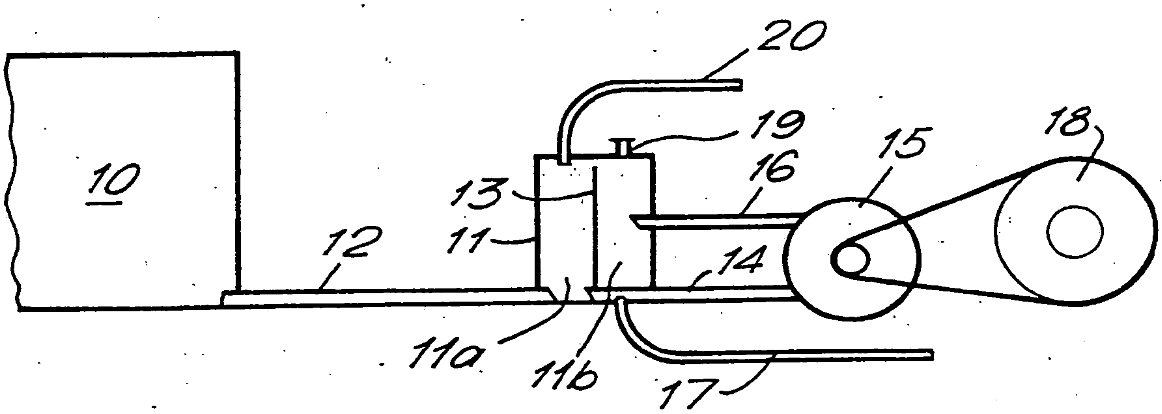


FIG.3.



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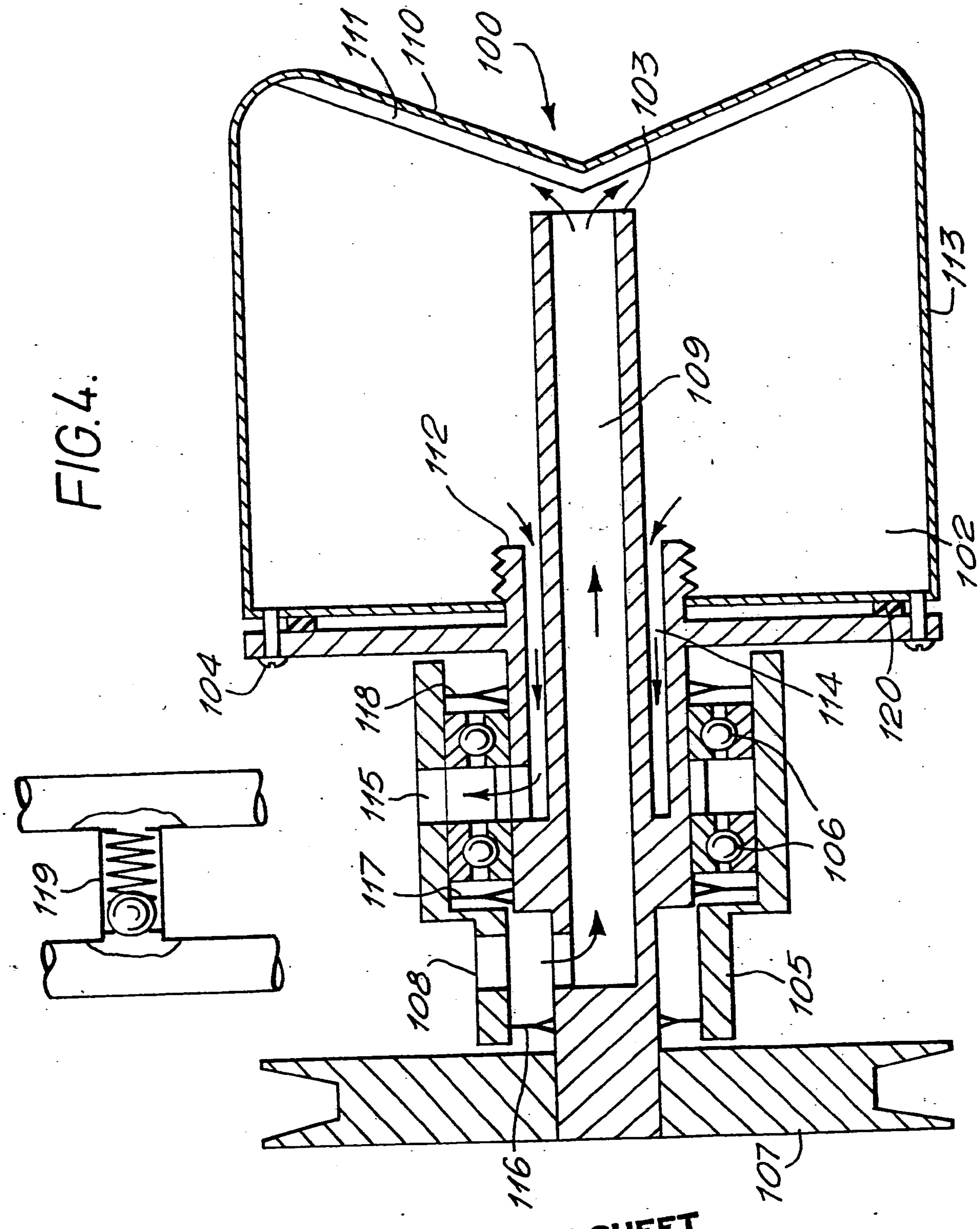

FIG.4.

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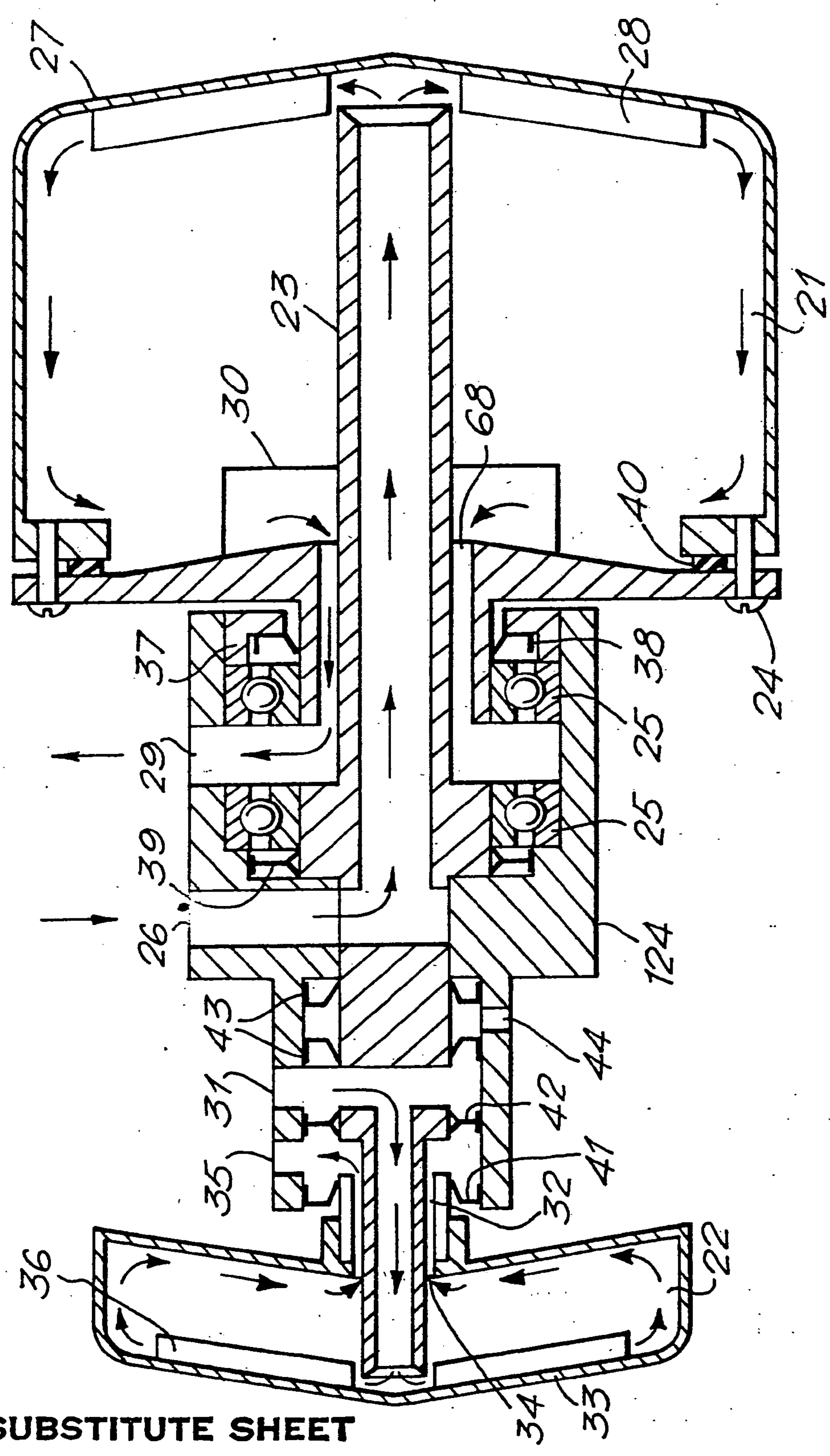
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FIG.5.

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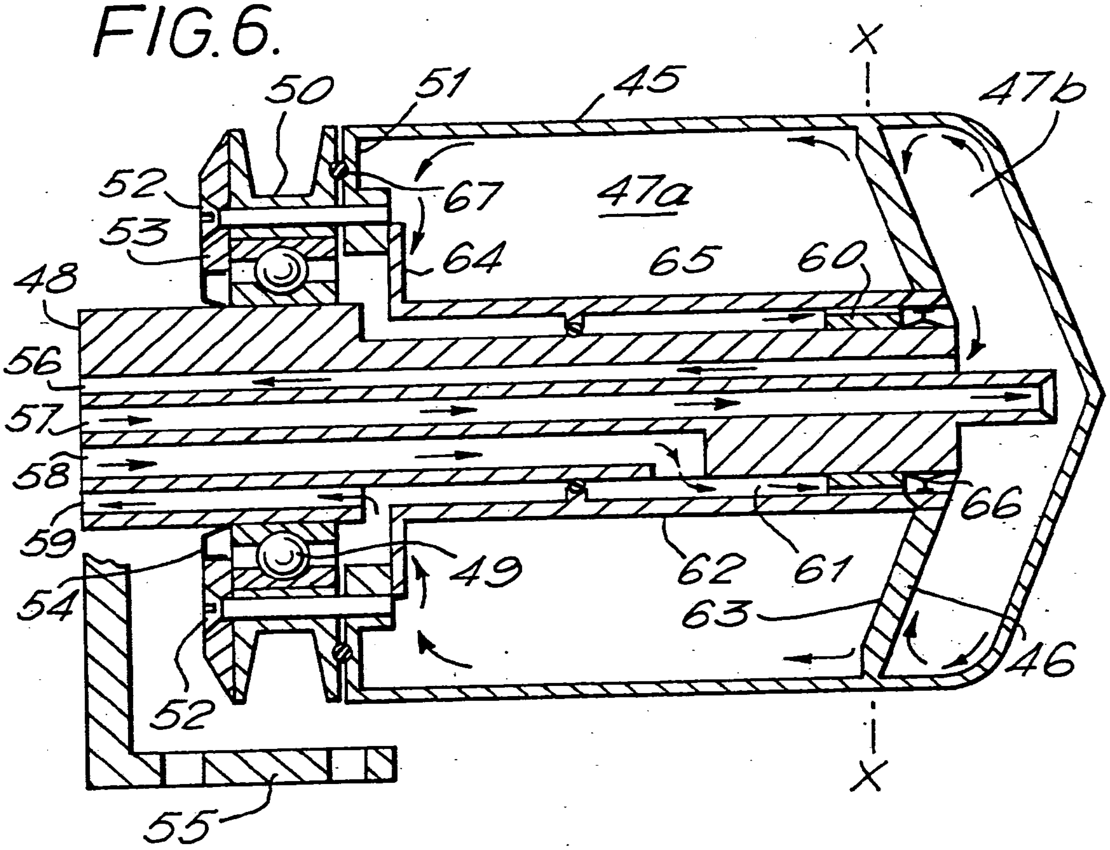
FIG.6.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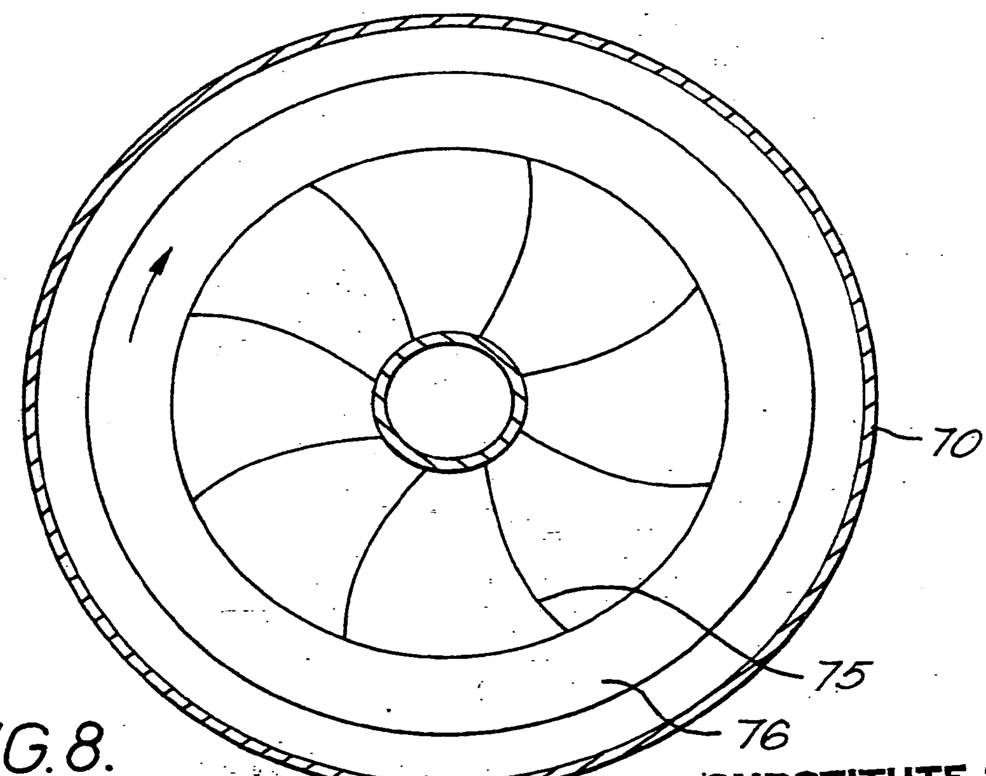
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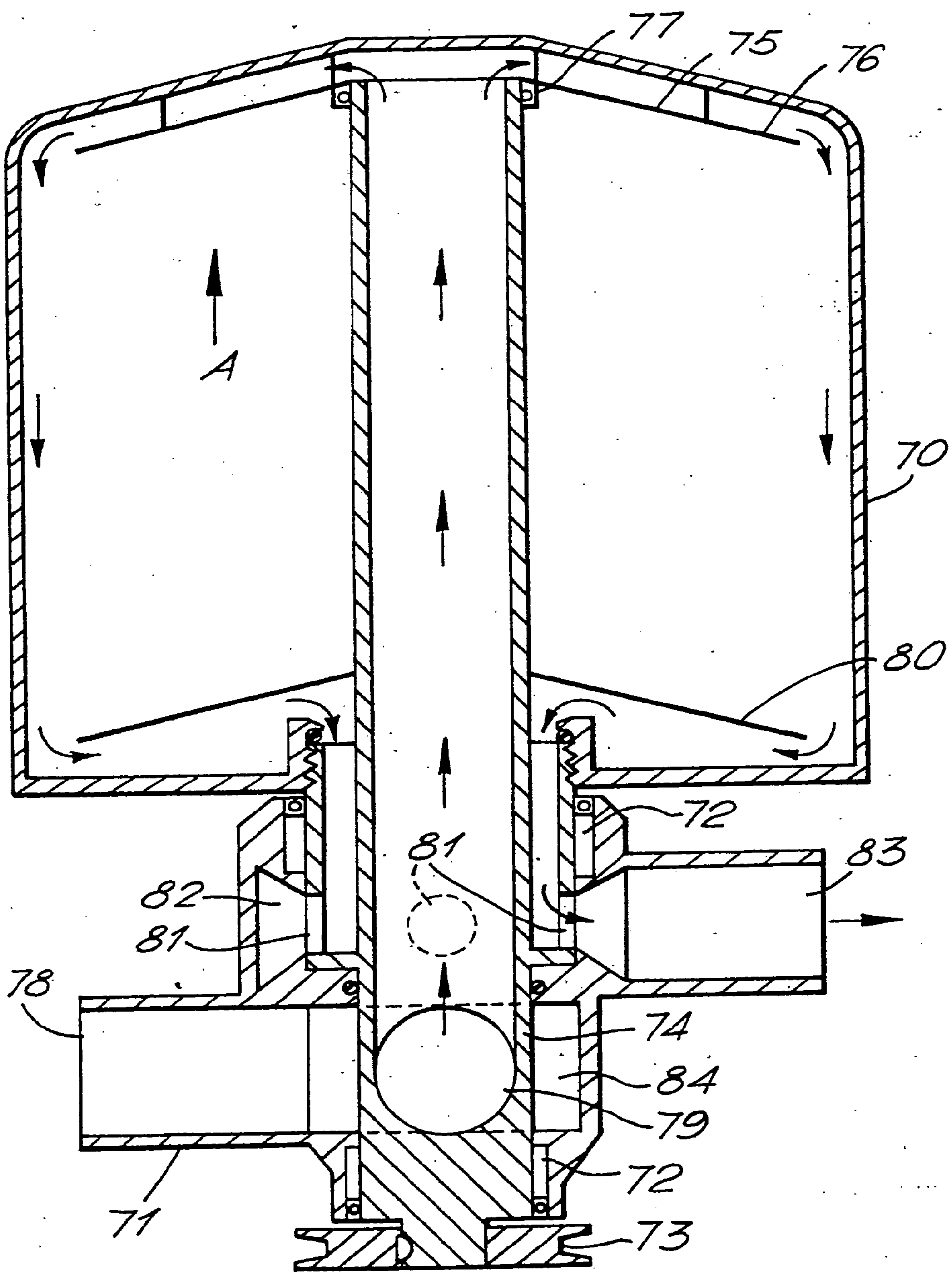
FIG.8.

FIG. 7.



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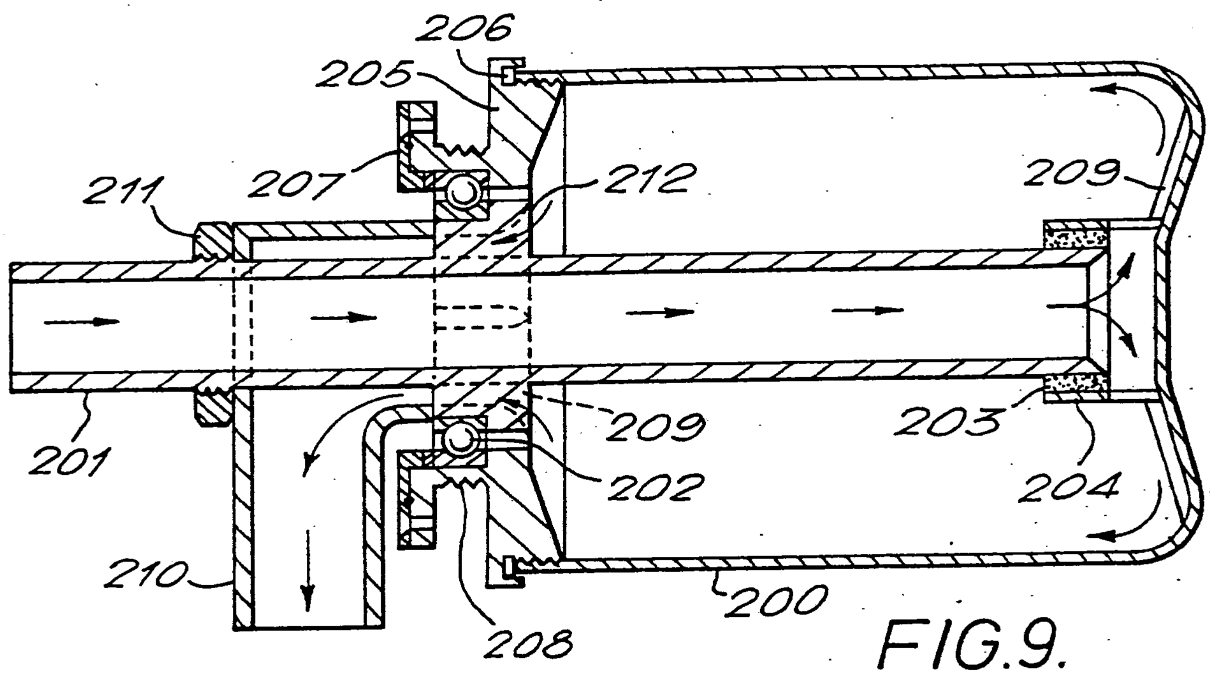

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FIG.9.

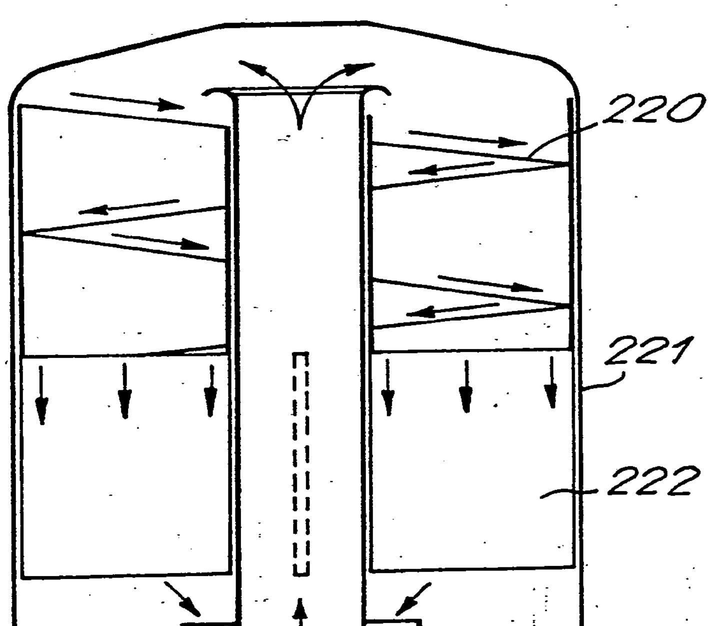

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FIG.10.